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US 5573378 A

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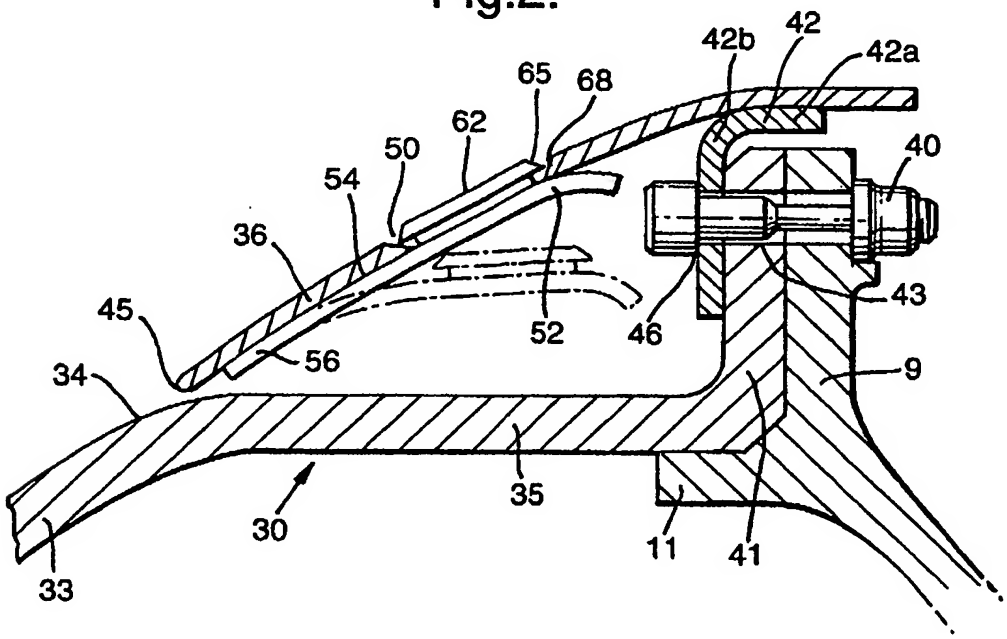
(54) Abstract Title
Gas turbine engine nose cone with tool access hole plug/cover

(57) A conical nose cone 34,36 for a gas turbine engine comprises a flange 41 having a first hole 43 for mounting the nose cone, and a second hole 50 in the nose cone substantially opposite the first hole for access to bolts 40 passing through the first hole. A resilient cover 52 for the second hole 50 is displaceable so bolts 40 may accessed by a tool. The cover 52 is attached to the inner surface of the nose cone adjacent the second hole and has a protrusion 62, which may be a mushroom shaped plug for a push fit into chamfered edges the second hole, or a grommet (86, fig 4) which substantially fills the second hole to maintain a smooth aerodynamic profile of the nose cone. Centrifugal forces during use act to keep the protrusion in the hole. In one embodiment, the cover (70, figs 4 and 5) may be made of rubber and semicircular in form with slits for flexibility. The nose cone may be one piece (71, fig 4), or comprise a spinner 34 and fairing 36.

Fig.2.



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At least one drawing originally filed was informal and the print repr duced here is taken from a later filed formal c py.

Fig.1.

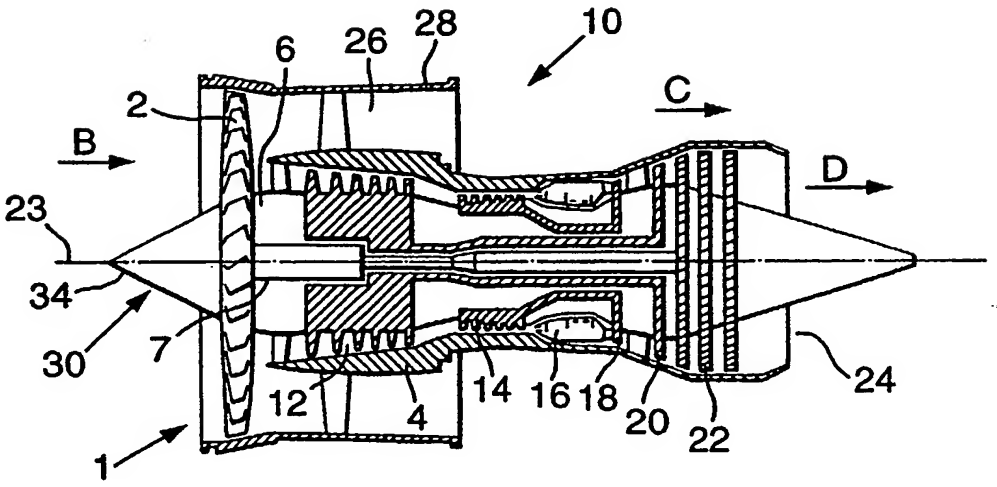


Fig.2.

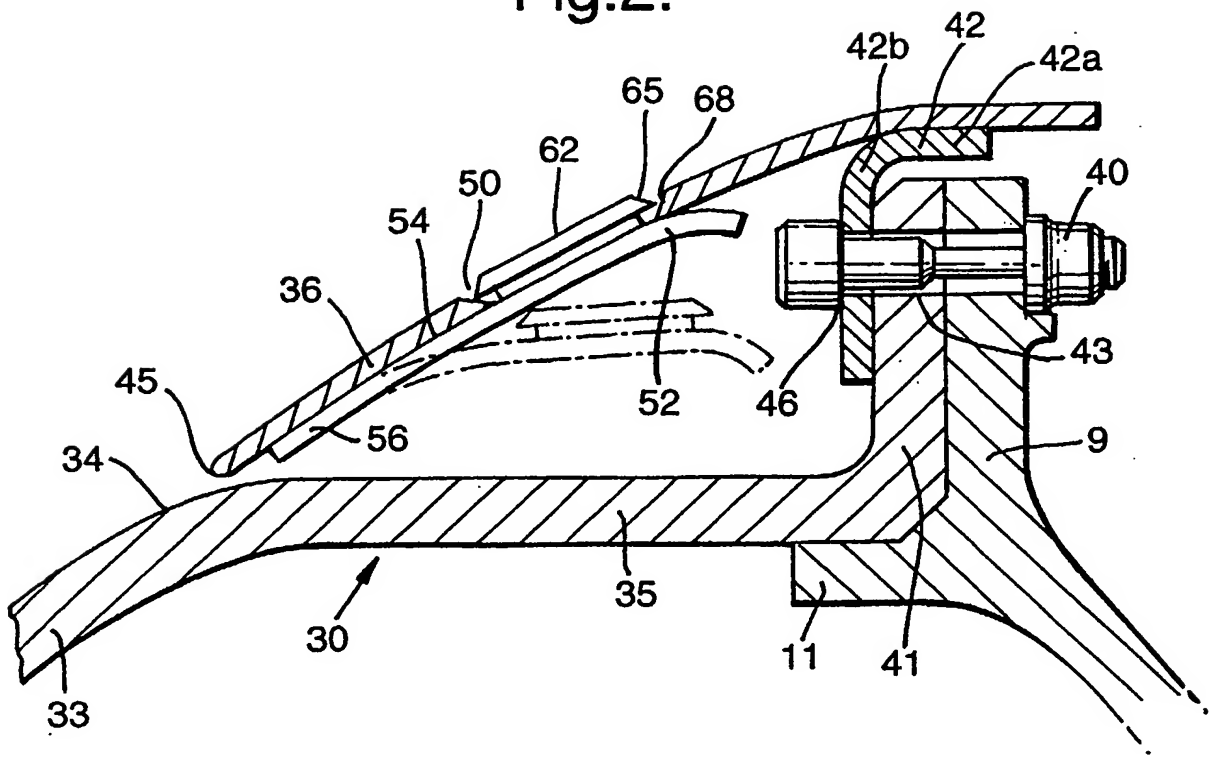


Fig.3.

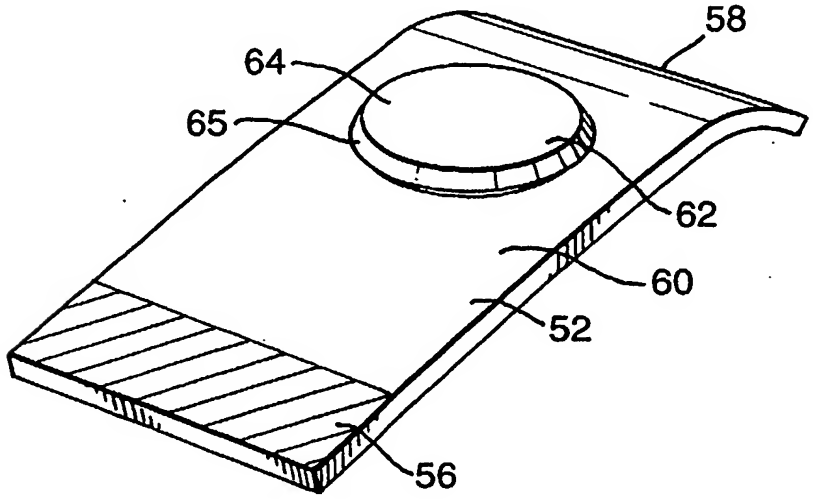


Fig.4.

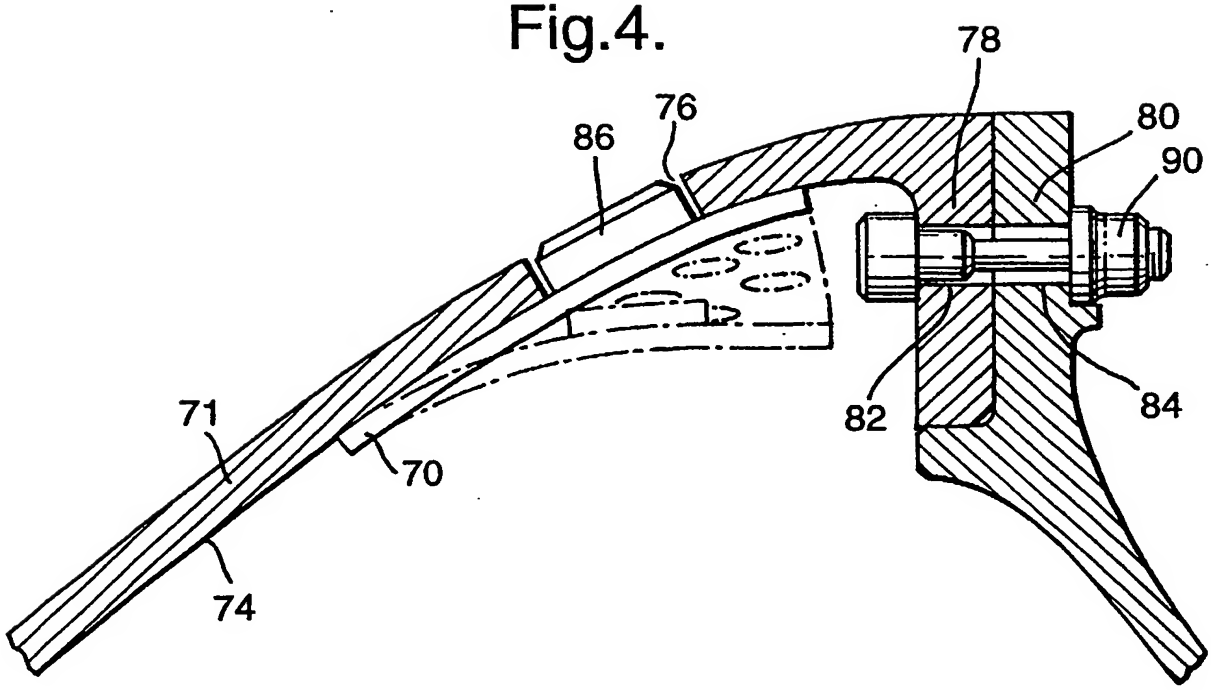
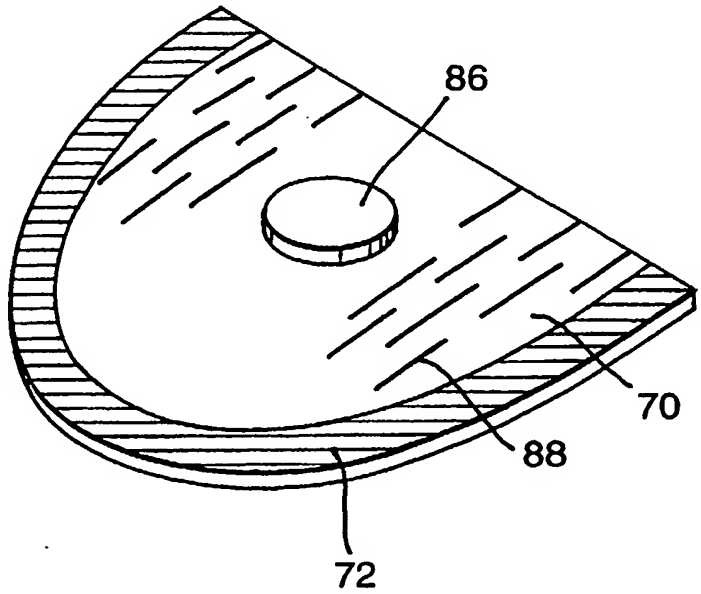


Fig.5.



GAS TURBINE NOSE CONE ASSEMBLY

The present invention relates to a gas turbine engine and in particular to the nose cone of a gas turbine engine fan hub.

A removable nose cone, also known as a spinner, is attached to and rotates with a hub in the centre of a gas turbine engine fan. This nose cone provides an aerodynamic surface covering the radially inner hardware and directs the inlet airflow smoothly into the hub region of the gas turbine engine fan.

Conventionally the nose cone is attached to the fan hub by a number of circumferentially spaced, axially extending bolts disposed around the base portion of the cone and engaging the fan hub assembly. To provide access to the bolts, for fitting or removing the nose cone, elliptical holes are provided in the nose cone. Alternatively pockets or indentations below the nominal surface of the cone are formed in the nose cone base region. The bolts are fitted within these pockets which are large enough to accommodate the heads of the bolts.

A problem with both of these arrangements is that the airflow into the fan, over the nose cone, is disturbed, in particular in the region surrounding the fan hub at the root portion of the fan blades. In the first arrangement some air flows into the elliptical holes and also the sharp edges of the hole effect and disturb the remainder of the flow of air passing over them. In the second arrangement there are more rounded edges to the pockets than are found with the holes, reducing the effect they have on the airflow passing over them. However the pockets are larger than the holes and as such disturb the

flow over a larger area of the nose cone. The airflow will also flow into these pockets producing eddy flows, which will again affect the airflow over the nose cone. Engine testing and analysis has shown that the disturbances to the airflow over the nose cone reduces the efficiency of the root portions of the fan downstream of the nose cone. This has in turn affected the overall engine performance.

The fabrication of a nose cone incorporating pockets is also complex and therefore expensive. The pockets within the nose cone, and to an extent, the holes, increase the stresses within the nose cone thus requiring the nose cone to be manufactured from thicker material than would otherwise be necessary. This undesirably increases the weight of the nose cone.

Prior US patent No. 5 573 378 discloses a nose cone mounted on a fan hub comprising access holes which allow a suitable tool, such as an Allen wrench, to be inserted and hence access the bolts securing the nose cone to the fan hub. When an access hole is not in use a spring clip extends over part of the inner surface of the nose cone and covers the hole. However, the airflow over the outer surface of the nose cone would still be disturbed by the recesses left by the holes as they are only covered on the inner surface of the nose cone. Also the spring arrangement is complex.

Co-pending GB application number 9828812.9 proposes a solution to the aforementioned problems by incorporating a fairing which surrounds the base of the nose cone and the bolt attaching the nose cone to the fan hub. The fairing provides an axially smooth continuous outer surface, the profile continuing that of the forward nose cone portion. However access to the bolt is cumbersome and the screw

fixing the faring to the fan hub and nose cone may disturb the air flow.

It is therefore desirable to provide an improved nose cone assembly that addresses the above problems and provides less disturbed airflow into the fan and/or offers improvements generally.

According to the present invention there is provided a nose cone assembly for a gas turbine engine comprising, a flange extending radially inwardly from an outer surface of said nose cone, a first hole in said flange, a second hole in said nose cone, said second hole providing access to said first hole, a resilient cover for said second hole wherein said resilient cover is attached to the inner surface of said nose cone adjacent said second hole so as to form a displaceable cover for said second hole and said cover being provided with a protrusion adapted to provide a displaceable plug within said second hole.

Also according to the present invention there is provided a nose cone assembly for a gas turbine engine comprising a spinner having a generally conical forward portion and a base portion, said base portion comprising a flange extending radially outwardly therefrom, a fairing arranged to surround the base portion of said spinner, said fairing being generally conical and when assembled, shaped to continue the profile of the forward spinner portion, a first hole in said flange, a second hole in said fairing, said second hole providing access to said first hole, a resilient cover for said second hole, characterised in that said resilient cover is attached to the inner surface of said spinner, adjacent said second hole so as to form a displaceable cover for said second hole and said cover being provided with a protrusion adapted to provide a displaceable plug within said second hole.

The invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic sectioned view of a ducted gas turbine engine incorporating a nose cone assembly according to the present invention.

Figure 2 is a detailed sectioned view of the nose cone assembly according to one embodiment of the present invention.

Figure 3 is a perspective view of the resilient cover, shown in situ in figure 2, according to an embodiment of the present invention.

Figure 4 is a detailed sectioned view of the nose cone assembly according to another embodiment of the present invention.

Figure 5 is a perspective view of the cover, shown in situ in figure 4, according to present invention.

Referring to figure 1, a turbofan gas turbine engine 10 comprises in flow series an inlet 1, a fan 2 and a core engine 4 comprising an intermediate pressure compressor 12, a high pressure compressor 14, a combustor 16, high pressure turbine 18, intermediate pressure turbine 20, low pressure turbine 22 and an exhaust 24. The fan 2, compressors 12, 14 and turbines 18, 20, 22 are all arranged to rotate about a central common axis 23. Air is drawn into the engine 10 as indicated by arrow B, through annular inlet 32 and into the fan 2. The fan 2 compressors the air and a portion flows, in a downstream direction into the core engine where it is further compressed, mixed with fuel and burnt in the combustor 16. The terms upstream and downstream are used with respect to the general direction of the gas flow through the engine 10. The high pressure high energy gas stream exiting the combustor 16 then flows through the turbines 18, 20 and 22

which extract energy from and are rotated by, the gas steam so driving the compressors 12, 14 and fan 2 via suitable shafts. The gas stream then exits the turbines through the exhaust and provides a proportion of the propulsive thrust of the engine 10. A second portion of the air compressed by the fan 2 flows around the core engine 4 and the engine casing 28. This flow of compressed air then exits the engine 10 as shown by arrow C providing a further portion of the engine thrust. As such the gas turbine engine is of a conventional design and operation.

The fan 2 comprises a number of fan blades, which are mounted upon a central fan hub 6 or disc. The fan hub 6 or fan annulus filler fairings (not shown in figure 1) attached thereto define an inner aerodynamic surface of the fan. The fan hub 6 is attached to a fan shaft 7, which in turn drivingly connects the fan 2 to the low pressure turbine 22. To provide a smooth flow of air through the inlet 1 and into the fan 2, a nose cone assembly 30 is attached to the fan hub 6. The nose cone assembly 30 has a generally conical shape with the axis of the cone, aligned with the engine axis 23 and extending in a downstream axial direction from a point vertex at an upstream end to a generally circular base adjacent the fan hub 6. The diameter of the circular base of the nose cone assembly 30 is substantially the same as that of the outer surface of the fan hub 6, or fan annulus filler fairing on the fan hub. The outer profile at the base of the nose cone assembly 30 is axially aligned with the outer profile of the fan hub 6 or fan annulus filler fairing defining the inner aerodynamic surface of the fan 2 at the innermost extent of the fan blade aerofoil.

Now referring to figure 2, in this embodiment of the present invention, the nose cone assembly 30 comprises a

spinner 34 and a fairing 36. The spinner is generally conical and the cone angle (the angle of the outer surface form the central cone axis which is this case is aligned with the engine axis 23) is varied such that the base portion 35 of the spinner 34 is developed into a generally cylindrical shape with an outer profile substantially parallel to the engine axis 23.

At the base of the spinner a flange 41 is provided which extends radially outwards form the cylindrical base portion 35 and is substantially perpendicular to the base portion 35 of the spinner 34 and the engine axis 1. It is to be appreciated that the base portion 35 of the spinner need not be necessarily parallel to the engine axis 1.

The flange 41 is provided with a number of axially extending holes 43 circumferentially spaced around the flange 41. The spinner 34 is fitted to the engine 10 using axially extending bolts 40 which pass through these holes 43 to attach and mount the spinner 34 to a co-operating fan hub flange 9 attached to, or integral with the fan hub 6.

As shown in this embodiment the fan hub flange 9 is provided with an axially extending extension on the radially inner end of the flange 9. A radially inner surface of the spinner 34 is arranged to rest upon this extension when being fitted to the fan hub 6 thereby radially locating the spinner 34 on the fan hub 6.

The fairing 36 is of a generally frustoconical self supporting shape and has a continuous, smooth radially outer surface. The fairing 36 is fitted, as part of the nose cone assembly 30, to the engine 10 and concentrically with the spinner 34 and engine axis 1. When fitted the fairing 36 is disposed radially outside of, and surrounds and covers the base portion 35 and flange 41 of the spinner 34. The outer surface of the fairing 36 smoothly

continues the profile of the front portion 33 of the spinner 34 towards, at its rear downstream end the inner aerodynamic surface of the fan 2 defined by the radially outer surface of the fan hub 6 adjacent the roots of the fan blades 2. The fairing provides a smooth aerodynamic air washed surface for air flowing into the engine inlet into the fan 2 of the engine 10.

The front end of the fairing 36 is dimensioned such that it abuts against the base portion 35 of the spinner 34 where the base portion 35 and forward portion of the spinner 34 meet. This front end of the fairing 36 is also thickened such that a radially inner face 45 at the front of the fairing 36 abuts against the spinner 34. This provides a degree of radial location of the front of the fairing 36 with the spinner 34.

The rear end of the fairing 36 is located and mounted via a flexible spring member or brackets equi-spaced around the circumference of the fairing 36 spinner flange, 4, and engine axis 23. A flange portion 42b of each finger 42 extends form an end of the main portion 42 and at an angle thereto. The flange portion 42b of the fingers 42 is attached to the spinner 34 and to the fan hub 6 when assembled, using the axial spinner mounting bolts 40, which pass through holes 46 provided in the flange portion 42b of the fingers 42.

The fingers 42 are arranged such that the main portion 42a of each of the fingers 42 is disposed radially outside of the flange portion 42b and extends in a generally axial direction parallel to and abutting the rear of the fairing 36. The main portion 42a of the fingers 42 is securely affixed to the inner surface 48 of the fairing by suitable means such as welding, bonding employing countersunk screws.

The fairing 36 is provided with a hole 50 substantially opposite the bolt 40 so as to provide access thereto and to allow assembly of the spinner 33 and fairing 36. A flexible flap 52 is securely fixed by suitable means such as bonding or welding at one end to the inner surface 54 of the fairing. This flap 52 is shown more clearly in figure 3.

The flap 52 is securely affixed at one of its ends 56 to the inner surface 54 of the fairing 36. The other end 58 of the flap 52 is free and slightly curved. The outer face 60 of the flap is provided with a raised grommet 62 designed to be able to form a press fit within the hole 50. The top portion of the grommet 62 is formed as a flange 64 so that in effect the grommet 62 is mushroom shaped. The flange 64 is provided with chamfered edges, which enable a press fit of the grommet 64 within the chamfered edges of hole 50.

During normal running of the engine centrifugal forces force the flap outwards so that the grommet 62 is secured in hole 50. Hole 50 is formed with chamfered edges 68 so that the flange 64 of the grommet 62 abuts these edges thereby forming a good fit of the grommet 62 within the hole 50. The initial position of the flap 60 is shown in broken lines in figure 2. Once in position the flange 64 of grommet 62 forms a smooth aerodynamic fairing surface. Advantageously during running of the engine the centrifugal forces ensure that the grommet remains in the hole 50 without the need for a complex spring arrangement. Also advantageously when the engine is not in use bolt 40 can be easily accessed by using a suitable tool such as an Allen wrench to push the grommet out from the hole and the flap into the position shown by the broken lines.

In a second embodiment of the invention, as shown in figures 4 and 5, a flap 70 is substantially semi-circular in shape and is secured to the inner surface of a nose cone 71 via the curved portion of the flap periphery 72. This periphery is securely bonded to the inner surface 74 of the nose cone 71. In this embodiment of the invention a fairing is not employed and an access hole 76 is formed directly in the nose cone 71.

The nose cone 71 forms a smooth aerodynamic profile and comprises an L shaped inwardly extending flange 78 at its downstream end. This flange 78 abuts a co-operating fan hub flange 80. The flange 78 and fan hub flange 80 are both provided with a number of axially extending co-operating holes 82, 84. The nose cone 71 is fitted to the engine 10 using axially extending bolts 90 which pass through these holes 82, 84 and mount the nose cone to the fan hub flange 80.

A grommet 86 is formed on the top surface of the cover 70 and shaped so as to substantially fill hole 76 when in position as shown in figure 4. The top surface of grommet 86, once the grommet is in position within hole 76 is flush with the outer surface of nose cone 71. Thus the smooth aerodynamic profile of the nose cone 71 is kept intact.

Cover 70 is formed from a resilient material such as rubber and is provided with a number of slits, which provide the cover 70 with sufficient flexibility for it to be bent into a channel configuration during use. In use a suitable tool such as an Allen tool would push against grommet 86 and hence apply pressure to the flap such that it forms a channel or groove along which the tool can slide to access the bolt 90. This embodiment of the invention advantageously provides a channelled access to

the fastening bolts 90 which guides and retains the bolts during assembly and disassembly.

Although this embodiment of the invention is shown without a fairing it is to be appreciated that this embodiment would be equally applicable to a nose cone and fairing assembly as shown in figure 2.

Claims

1. A nose cone assembly for a gas turbine engine comprising, a flange extending radially inwardly from an outer surface of said nosecone, a first hole in said flange, a second hole in said nose cone, said second hole providing access to said first hole and a resilient cover for said second hole wherein said resilient cover is attached to the inner surface of said nose cone adjacent said second hole so as to form a displaceable cover for said second hole and said cover being provided with a protrusion adapted to provide a displaceable plug within said second hole.

2. A nose cone as claimed in claim 1 wherein said top surface of said protrusion is provided with a flange and the circumference of said second hole is chamfered such that said protrusion forms a displaceable press fit location within said hole.

3. A nose cone as claimed in any one of the preceding claims wherein the height of said protrusion is equal to the depth of said second hole such that once located within said hole the top surface of said protrusion lies in that same plane as the nose cone outer surface.

4. A nose cone as claimed in any one of the preceding claims wherein said cover is a flap.

5. A nose cone as claimed in claim 4 wherein said flap is substantially rectangular and is bonded at one of its ends to the inner surface of said nose cone.

6. A nose cone as claimed in claim 5 wherein said the free end of said flap is flared.

7. A nose cone as claimed in claims 1 to 3 wherein the cover is substantially semicircular.

8. A nose cone as claimed in claim 7 wherein the curved part of said semicircular cover is affixed to the nose cone and the straight edge thereof is free.

9. A nose cone as claimed in claim 8 wherein slits are formed within said cover so as to provide flexibility therein.

10. A nose cone as claimed in any one of the preceding claims wherein said cover is manufactured from flexible rubber.

11. A nose cone as claimed in any one of the preceding claims wherein a bolt secures the nose cone to the fan hub through said first hole and a corresponding hole formed in the fan hub.

12. A nose cone assembly for a gas turbine engine comprising a spinner having a generally conical forward portion and a base portion, said base portion comprising a flange extending radially outwardly therefrom, a fairing arranged to surround the base portion of said spinner, said fairing being generally conical and when assembled shaped to continue the profile of the forward spinner portion, a first hole in said flange, a second hole in said fairing, said second hole providing access to said first hole, a resilient cover for said second hole, wherein said resilient cover is attached to the inner surface of said spinner adjacent said second hole so as to form a displaceable cover for said second hole and said cover being provided with a protrusion adapted to provide a displaceable plug for said second hole.

13. A nose cone as claimed in claim 12 wherein that the height of said protrusion is equal to the depth of said second hole such that once located within said hole the top surface of said protrusion lies in that same plane as the fairing outer surface.

14. A nose cone as claimed in claim 12 or claim 13 wherein said cover is substantially rectangular and is affixed at one of its ends to the inner surface of said fairing.

15. A nose cone as claimed in claim 12 or claim 13 wherein the cover is substantially semicircular, the curved part of said semicircular cover being affixed to the nose cone and the straight edge thereof being free.

16. A nose cone as claimed in claim 15 wherein slits are formed within said cover so as to provide flexibility therein.

17. A nose cone as described herein with reference to the accompanying drawings.

Application No: GB 0017357.5
Claims searched: 1-16
Examiner: Terence Newhouse
Date of search: 17 October 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): F1V(VCF)

Int Cl (Ed.7): B64C 11/02 11/14; F02C 7/04 7/045 7/05 7/055

Other: ONLINE: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 5573378 (UNITED TECHNOLOGIES), see figs 3A-3D noting resilient cover 44	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.